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Insect Control-Sierra
San Joaquin Project

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# FIRST ANNUAL REPORT

## SAN JOAQUIN INSECT CONTROL PROJECT

## SIERRA NATIONAL FOREST

Duplicate

Approved:

7/14/21 (Date) M A Benedict Forest Supervisor.

7/14/21 J M Miller Assistant Forest Entomologist.

8/1/21 Paul G. Redington. District Forester.

7/21/21 L Woodbury Assistant District Forester.

Submitted by:

J. M. MILLER,
Assistant Forest Entomologist.

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# FIRST ANNUAL REPORT

## SAN JOAQUIN INSECT CONTROL PROJECT

I. PRELIMINARY STATEMENT: Purpose, location and conditions of project.

1. Purpose:

Prior to the inauguration of the San Joaquin Project all of the Insect Control work in yellow and sugar pine type in District Five has been directed toward checking well developed epidemics of Dendroctonus beetles.

The first work was started in 1911, and up to 1920 approximately $90,000 had been spent by Federal and private owners in treating twenty million feet of infested timber in California. The methods used were those outlined in publications of the Federal Bureau of Entomology. Infested trees which were found upon the areas under protection were felled, the bark removed, and in the case of yellow pine*, burned. This work was usually confined to the treatment of broods in the overwintering condition, which limited the working period to three or four months in the winter and spring.

The results of this earlier control work have demonstrated conclusively that the annual loss by the beetles can be reduced and the epidemic condition controlled by the application of these methods. On nearly all projects, however, this work was discontinued when an improvement had been affected. Lack of funds and absence of a definite policy has limited control work to emergency situations only.

This system of combating infestations, if followed as a policy, has certain disadvantages. Administration of the control work is difficult because of the short working period and unsettled character of the work. After the epidemic has been controlled, work ceases, the trained personnel is dispersed, and the area is left without provision for meeting any new epidemics that might arise. There is no insurance that the results obtained from the initial work will be protected.

These facts have been realized for a number of years by those who have been engaged in insect control work. It was evident that after mopping up the epidemics in any large Forest region some permanent system should be maintained in order to protect this

*Note: The bark of treated sugar pine was also generally burned in Forest Service work, partially as a fire protection measure.
T.D.W.

initial investment of protective funds. This idea was originally suggested in Bulletin #83, under the discussion of "How to Maintain Control".

A cooperative scheme, initiated by the Bureau of Entomology and Forest Service representatives of Districts Five and Six, recommended in 1919 a definite project to test out this idea of control. The plan involved:

(a) The selection of a large representative area of yellow pine type, well defined by type and topographic boundaries.

(b) A general cleaning-up of the entire area to remove epidemic conditions.

(c) Initiation and continuation for a period of five years of protective work designated as the maintenance system of control. This involves enough work each year to hold the insect infestation to a minimum. The methods differ from those used previously, in that work will be conducted during the summer season. Trap trees and the solar heat methods of destroying broods are also innovations tested out on this project.

(d) Combining insect control to a certain extent with the fire protection of the same area. This is made possible by the fact that as the work is carried out during the fire season, the insect control crew can serve as a patrol and a potential fire fighting crew for emergencies.

2. Conditions of the San Joaquin Area:

The belt of pine timber lying on the northern drainage of the San Joaquin River basin was recommended as the testing ground for this work. This area, about 20 miles long by 18 miles in width, includes about 130,000 acres of pine type with two billion feet of stumpage. It is protected by complete type barriers on at least three sides.

The ownership of this timber can be divided into two main blocks; one privately owned, the other under the control of the Forest Service. At least 75% of the area is under the administration of the Sierra National Forest.

3. History of Past Infestation and Control Work:

The course of the pine beetle infestation on this area, so far, as it can be estimated for the period from 1913 to 1919, inclusive, is shown in Chart #1. Up until 1917, the seasonal losses shown in this chart are based upon rough estimates, arrived at by applying the ratio of the volume of timber treated on limited acreages to the entire area. In 1917, a complete survey was made of the entire area and the losses given for that season are considered

fairly accurate. The losses given for 1919 are based upon an actual marking of all trees killed during the season. The chart shows a distinct cycle in the course of the infestation, which reached its height in 1915. This conforms to the general observations of Forest officers familiar with the area during this period.

These estimates show a loss for the period in excess of thirty-three million feet, or an average annual loss of about 4,800,000.

Until the close of the 1919 season, $23,760.00 had been spent in the treatment of about seven million feet of infested timber, about equally divided between the Federal and private holdings. During the period covered, the plan of carrying out a project to cover the entire pine belt of the watershed, or the area outlined for this experiment, was not attempted. Not over 40% of the area of this body of timber was covered by the work of any one season.

4. INITIATION OF MAINTENANCE SYSTEM OF CONTROL:

In the spring of 1920, the problem of control was undertaken from the standpoint of the entire infested area. A general attack was made upon the overwintering infestation throughout the entire pine belt. This was followed during the summer by the maintenance work, the detail of which is described in the following sections of this report. This plan involved:

1. Treatment of infested trees whenever they can be found at accessible points.

2. Cutting of trap trees to localize infestation at accessible points.

3. Use of the solar heat method of destroying broods when infestedbark could not be burned with safety.

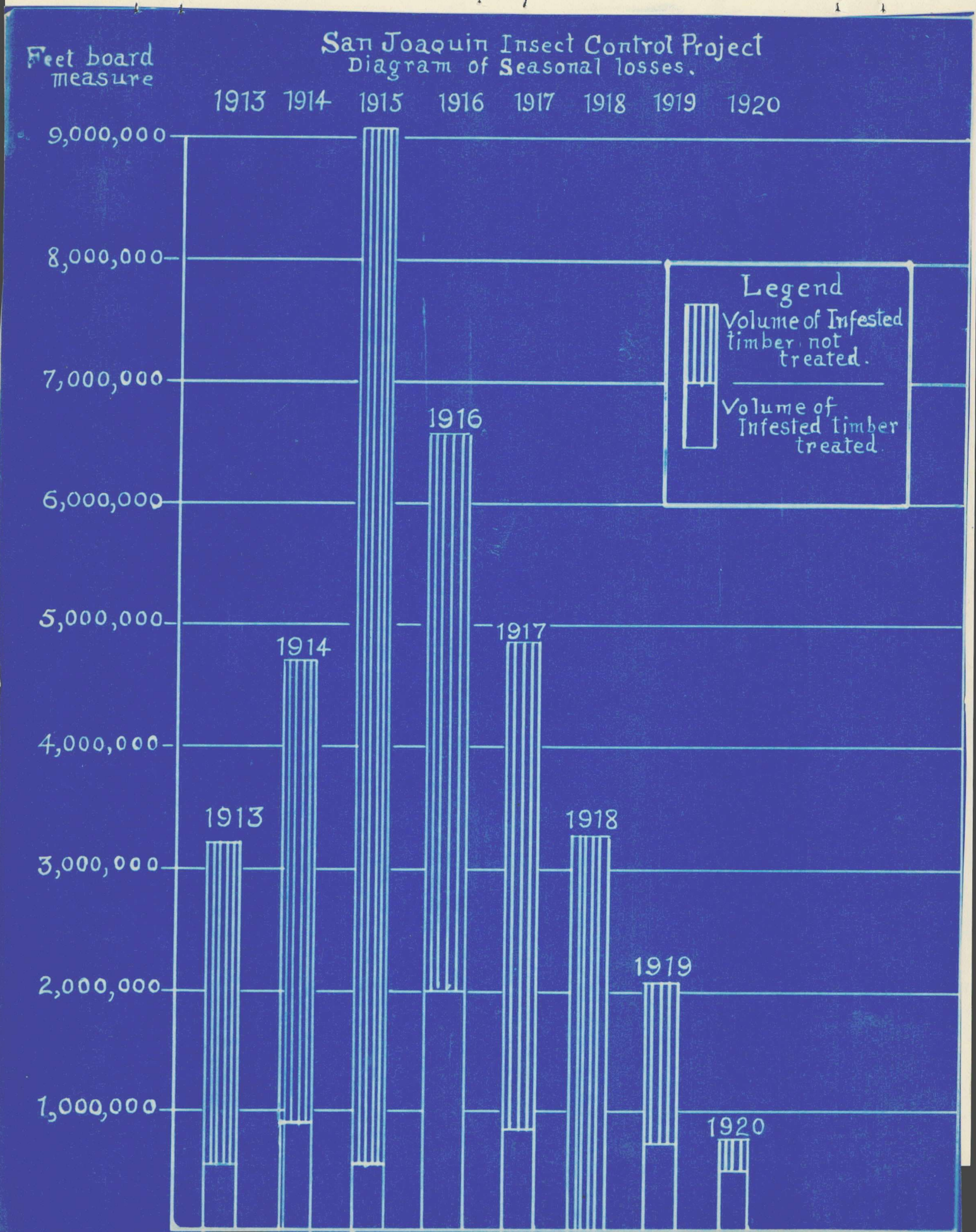
The results of the 1920 season indicate that the trap tree and solar heat methods can be successfully applied under the conditions of this project.

The most economical and efficient system of applying this method from an administrative standpoint is yet to be determined. This is now the principal investigative feature of the project, which will be continued until 1925, in order to determine the most feasible system of administration and the protective results which can be obtained by the continued application of this method.

II. AMOUNT AND CHARACTER OF INFESTATION DURING THE SEASON OF 1919:

1. Seasonal loss in Pine Timber:

During the progress of the 1920 work a marking was made and form records kept of all abandoned trees attached during the 1919


San Joaquin Insect Control Project
Diagram of Seasonal losses.
Feet board measure
1913 1914 1915 1916 1917 1918 1919 1920
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
Legend
Volume of Infested timber not treated.
Volume of Infested timber treated.
1913
1914
1916
1917
1918
1919
1920

season. An actual marking was made of 1165 trees, with a volume of 2,043,410 board feet on the part of the area covered by control work. This does not include the patented lands of the White and Friant Lumber Company in Unit 29 or the headwaters of the Chiquito, Jackass, Kaiser and Daulton basins, where the fir and jeffrey pine type predominate over the yellow pine. An estimate based upon a spotting of those outlying areas would increase this amount of seasonal loss by about 15%, making a total of 2,349,500 board feet killed during the season of 1919.

This distribution of the 1919 loss which was actually marked is shown in the following table:

TABLE #1

| UNIT | SPECIES | SUMMER BROOD TREES | | OVERWINTERING BROOD TREES | | | |
|---|---|---|---|---|---|---|---|
| | | | | UNTREATED | | TREATED SPRING 1920 | |
| | | Number | Volume | No. | Volume | Number | Volume |
| 24 | Y.Pine | 27 | 33,340 | 25 | 35,450 | 5 | 12,210 |
| Hogue | S.Pine | 2 | 3,030 | -- | -- | - | -- |
| 24 (a) | Y.Pine | 123 | 161,700 | 53 | 56,850 | 104 | 146,190 |
| North Fork | | | | | | | |
| 26 | Y.Pine | 212 | 325,830 | 40 | 103,330 | 98 | 190,870 |
| Chiquito | S.Pine | 11 | 54,530 | 4 | 14,860 | 18 | 64,430 |
| 28 | Y.Pine | 104 | 186,530 | 17 | 16,750 | 56 | 102,880 |
| Daulton | S.Pine | 17 | 72,180 | 3 | 7,350 | 27 | 73,270 |
| 29 | Y.Pine | 19 | 70,150 | 1 | 2,000 | - | -- |
| S & W | Y.Pine | 5 | 44,310 | 1 | 15,000 | 5 | 31,260 |
| 30 | Y.Pine | 131 | 134,190 | 6 | 8,580 | 57 | 94,340 |
| Crane Valley | | | | | | | |
| TOTALS: (Both Species) | | 651 | 1,087,790 | 150 | 240,170 | 370 | 715,450 |

It will be noted that 53% of this loss was classed as summer brood trees, which were attacked during the spring and summer and abandoned before fall. The remaining 47% were overwintering brood trees, those attacked in the late fall and summer in which the broods overwintered until the spring of 1920 and which composed the infestation found upon the area when control work was initiated in the spring of 1920. A slight but appreciable decrease in the volume of infestation during the advance of the 1919 season is indicated by these data.

The volume of infestation which developed in 1919 was somewhat less than that which occurred during seasons immediately preceeding. Reliable data as to seasonal loss of preceeding years for the entire area is available only for the season 1917. From figures secured by the survey of that season the loss of the two seasons compare as follows:

| | 1917 | | 1919 | |
|---|---|---|---|---|
| | VOLUME FT.B.M. | PERCENT | VOLUME | PERCENT |
| Yellow Pine Loss, | 2,024,000 Feet, | 44% | 1,911,600 Ft. | 82% |
| Sugar Pine Loss, | 2,592,000 " | 56% | 437,900 " | 18% |
| TOTALS: | 4,616,000 Ft.B.M. | 100% | 2,349,500 "B.M. | 100% |

A reliable marking and estimate of the 1918 loss could not be obtained in 1920 as the foliage has now fallen from the majority of the trees killed during the season. It is considered, however, that this loss was somewhat less than 1917 and greater than 1919.

The above data shows that the yellow pine loss in 1919 was 5.5% less than that of 1917, while the sugar pine loss was 83% less. This reduction is accounted for mainly by the elimination of the Dendroctonus Monticolae infestation in Unit 29 (Sand and Whiskey Creek) where more than two million feet of sugar pine were treated by the White and Friant Lumber Company in 1917.

2. Primary Infestation Involved:

Dendroctonus Beetles: Over 90% of the loss recorded is due to the western pine beetle Dendroctonus brevicomis in yellow pine and the mountain pine beetle, Dendroctonus monticolae, in sugar pine. The killing occurs mainly in mature trees, the average volume of yellow pine being 1770 B.F. and of sugar pine 4708 B.F. The merchantable volume of timber killed by Ips is scarcely noticeable, the same being true of trees killed by flathead larvae (species of Melanophila). A few trees were found which contained no insect infestation of any kind, although the foliage was in a fading condition.

Killing of trees in groups: An exception to the usual character of timber killed by bark beetles on this area was found in the spring of 1920. Along a few of the small tributary creeks groups of small trees were found containing overwintering infestation. These groups occurred in pole stands, the trees ranging from four to twenty-four inches D.B.H., and were located in the form of long narrow strips following the channel of the stream. Four of these groups were found on the area all in Unit 24 (a). The largest group was marked and analyzed and was found to consist of the following classes of loss:

| | 1917 Loss | | 1918 Loss. | | 1919 Loss | |
|---|---|---|---|---|---|---|
| | NO. TREES | VOLUME | NO. TREES | VOL. | TREES | VOL. |
| Trees under 10" D.B.H. | | | 24 | | 16 | |
| Trees over 10" D.B.H. | 20 | 2430 | 18 | 1620 | 46 | 5620 |
| Top-killed trees, | 5 | | 2 | | 41 | |
| TOTALS: | 25 | 2430 | 44 | 1620 | 103 | 5620 |

Total loss for three years, 172 trees; volume, 9760 Feet B.M.

Those groups, although conspicuous, were a minor factory both as regards volume of infestation and the amount of merchantable timber killed. The greater part of the infestation in them was found to be Dendroctonus brevicomis and only a few were found that contained Ips oregonis except in the tops.

This type of infestation practically disappeared during the season of 1920. Only one group appeared during the season, consisting of 2,110 board feet in 20 trees, located at the extreme western edge of the project in Unit 30.

III. CONTROL WORK, SEASON OF 1920:

1. Treatment of Overwintering Infestation:

(a) Volume and percent of total infestation treated: A total of 520 trees, containing overwintering broods with a volume of 955,620 feet were marked within the area during the spring of 1920. Of this amount 375 trees with a volume of 715,450 board feet, or approximately 74%, were treated. Including outlying trees bordering the control area which were not marked, the amount of the infestation actually treated was not over 70%.

(b) History of work: Preliminary cruising, marking and mapping of the project started February 28th. This work was continued in advance of the control crews until May.

Actual control work and treatment of infested trees was started March 8. The first work was located on the most accessible part of the project area in vicinity of Northfork (Unit 24-a). Two working crews of four men (three workmen and cruiser) were employed on the average. No camp was established, but the men were boarded at the Southfork Hotel and the Forest Service truck was used to take them to and from work. The treatment of infested trees which could be reached in this way was completed April 3. During this period nearly all men employed were under statuatory appointment and work was interfered with to quite an extent by frequent storms.

On April 5, twelve men were started for the Chiquito Basin. One man from this crew was assigned as packer for the entire time that the work was in progress in the back country. This crew was divided and seven men were assigned to work out the Chiquito Basin. Four men spent three days treating the trees found in the lower part of the Rock Creek Basin. They were then moved to the Daulton basin and worked on this unit until the control work was closed down in the back country on May 27.

A crew of four men started work in the Cascade basin on April 6, and was increased later to 7 men, on April 19. On May 2 this crew was moved to Crane Valley and continued work on this Unit until May 15.

Practically all of infested trees treated were on National Forest lands with the exception of a few trees on small holdings in the Northfork and Crane Valley Units. The large block of patented

timber known as the White and Friant tract was not included in the control work. This was because the infestation on this land was very light compared with other parts of the area, and the owners of the tract did not think the situation serious enough to justify the expenditure of funds.

The primary object of the spring work was to reduce the heaviest bodies of infestation throughout the area. In order to accomplish this in one season it was necessary to maintain three separate camps at different points as described above.

(c) Costs: The following data shows costs of the 1920 spring work:

Period of work----------February 26 to May 27.
Acreage covered:----------95,000. (Remaining 35,000 acres of project covered only by summer maintainence work).

Average number men employed, 15.
Number trees treated, 370.
Total volume treated, 715,450.
Total cost of work, $4,909.65.
Cost per M.B.M., $6.86.

2. Summer Maintenance Work:

(a) Volume and character of infestation developing during season: Following the removal of this infestation in the spring of 1920, it was fully expected that a certain amount of reinfestation would develop during the following summer season. The object of the maintenance work was not to treat all the new infestation, which would be impossible, but to treat as much of it as can be handled by two small crews covering the entire area and using trap trees as a means of attracting the infestation which cannot be located in time or which is too inaccessible to treat in standing infested trees. A comparison of the amount and character of infested timber and volumes treated is shown by graph in Chart #2.

TABLE #2.

Infestation developing upon the area during the season of 1920 as shown by records of trees marked up to January 1, 1921.

| Unit | Species | Standing Trees Killed | | Windfalls | | Trap Trees | |
|---|---|---|---|---|---|---|---|
| 24 Hogue | Yellow P. | 18 | 24,210 | 19 | 32,460 | 20 | 23,810 |
| | Sugar P. | | | 1 | 6,100 | | |
| 24a Northfork | Yellow P. | 43 | 87,690 | 63 | 69,410 | 43 | 63,360 |
| | Sugar P. | | | | | | |
| 26 Chiquito | Yellow P. | 42 | 83,840 | 35 | 70,100 | 75 | 138,400 |
| | Sugar P. | 12 | 48,720 | 9 | 39,680 | 3 | 12,100 |
| 28 Daulton | Yellow P. | 16 | 29,540 | 8 | 21,120 | 35 | 26,630 |
| | Sugar P. | 1 | 3,300 | 12 | *51,810 | | |
| 29 Sand and Whiskey Cr. | Yellow P. | 1 | 4,930 | 15 | 37,650 | 4 | 6,280 |
| | Sugar P. | 5 | 12,510 | 12 | 51,810 | 3 | 7,130 |
| 30 Crane Valley | Yellow P. | 33 | 52,730 | 13 | 12,600 | 20 | 24,390 |
| | Sugar P. | | | | | | |
| Totals | Yellow P. | 153 | 282,940 | 153 | 243,340 | 197 | 282,870 |
| | Sugar P. | 18 | 64,530 | 22 | 97,590 | 6 | 19,230 |
| Totals Both Species | | 171 | 247,470 | 175 | 393,740 | 203 | 302,100 |

*An additional 252,730 feet of windfalls occurred on this unit but were not attacked owing to low ebb of infestation.

This shows a total of 549 trees with a volume of 943,310 board feet, representing the seasonal infestation on the area. These data, however, represent only infested trees, detected up until the close of the season. Green trees which were not located in the fall and not fading until the spring of 1921 are still to be added. Data which will be collected in the spring of 1921 may increase this volume from 25% to 50%.

(b) Volume of Timber Treated in Summer Work:

# San Joaquin Insect Control Project

Diagram of losses, Season of 1919 and 1920, Showing Volumes Treated.

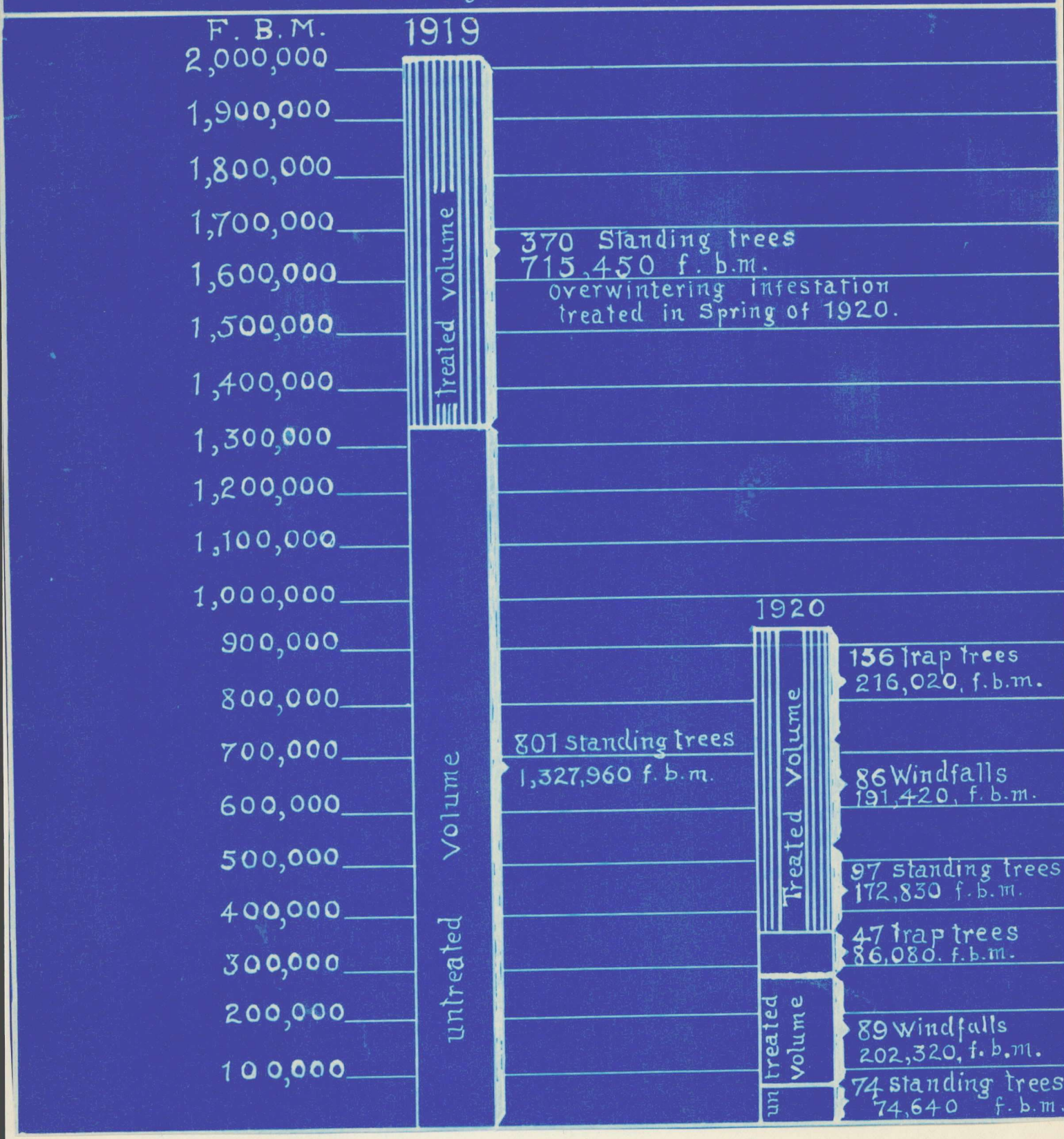


TABLE #3.

Volume of infested timber treated during progress of summer maintenance work:

| Unit | Species | Standing Trees Killed | | Windfalls | | Trap Trees | |
|---|---|---|---|---|---|---|---|
| 24 Hogue | Yellow P. | 18 | 24,210 | 10 | 20,080 | 19 | 22,750 |
| | Sugar P. | | | | | | |
| 24a Northfork | Yellow P. | 23 | 49,910 | 35 | 42,060 | 35 | 56,280 |
| | Sugar P. | | | | | | |
| 26 Chiquito | Yellow P. | 16 | 24,950 | 14 | 36,830 | 45 | 72,020 |
| | Sugar P. | 5 | 21,950 | | | 3 | 12,100 |
| 28 Dalton | Yellow P. | 6 | 12,450 | 2 | 8,560 | 30 | 20,960 |
| | Sugar P. | | | | | | |
| 29 Sand W | Yellow P. | 1 | 4,930 | 4 | 22,580 | 2 | 3,520 |
| | Sugar P. | 1 | 3,900 | 12 | 51,810 | 2 | 4,000 |
| 30 Crane Val. | Yellow P. | 27 | 40,530 | 9 | 9,500 | 20 | 24,390 |
| | Sugar P. | | | | | | |
| Total | Yellow P. | 91 | 146,980 | 74 | 139,610 | 151 | 199,920 |
| | Sugar P. | 6 | 25,850 | 12 | 51,810 | 5 | 16,100 |
| Total Both Species | | 97 | 172,830 | 86 | 191,420 | 156 | 216,020 |

Total volume treated, 338 trees - 598,510 feet.

(c) History of Work: The organization and plan of work outlined in the working plan of June 1, 1920, was followed with a few modifications.

The Northfork district, which included about 80,000 acres, was worked by a crew of two men with automobile. This crew started work June 15 and under Ranger Wagner made three successive trips over the area from the head of Crane Valley to Rock Creek. The third trip was completed September 26th.

The Chiquito district of 50,000 acres was worked by a two man crew traveling with burro pack outfit. But two trips were made over this part of the area. The crew quit work on September 10, and the treatment of traps left by them was completed by the Northfork crew which worked in the Chiquito basin from September 28 to October 25.

(d) Costs: During favorable periods in November, treatment of infested traps and standing trees in the Northfork district was resumed. About nine days were spent on this work by Mr. Wagner and one other man under statuatory appointment.

## COSTS OF SUMMER MAINTENANCE WORK

The total costs and results of the summer maintenance work based upon records revised to January 1, 1921, stands as follows:

| | |
|---|---|
| Period of work | June 15 to December 31, 1920 |
| Total acreage covered | 130,000 |
| Number of men employed | 4 |
| Number of trees treated | 338 |
| Volume of timber treated | *598,510 board feet |
| Total cost of work | $2,259.31 |
| Cost per M.B.M. | $3.78 |

*This does not include 66,000 feet of trap trees felled but not treated in 1920. Some of this will be treated in the 1921 work.

## DISTRIBUTION OF COSTS

| | |
|---|---|
| Labor | $1,676.53 |
| Subsistence | 473.00 |
| Transportation | 109.78 |
| Total | 2,259.31 |

## IV ANALYSIS OF SUMMER INFESTATION AND METHODS OF TREATMENT EMPLOYED.

### 1. Standing trees attacked:

Table #2 shows that 171 standing trees with a volume of 247,470 board feet were attacked during the season. This amount may be increased by as much as 100,000 board feet when all tree records marked in the spring of 1921 are available. The possible total of 350,000 feet, however, may be compared with 2,043,400 board feet of standing trees attacked in 1919.

It is evident that when final records are available it will be found that not over 50% of the infestation developing in standing infested trees was treated in the summer work. This is partly due to the fact that a number of the summer brood trees were inaccessible. However, the more important reason for failure to treat a higher percent of these standing trees, was the fact that they were abandoned by the time they were detected. The rapid development of broods during the summer period allows for emergence of new adults within a very short time after the foliage fades. During the five weeks' interval between cruising dates many green trees changed to fading foliage and the broods emerged before they were detected and marked.

### 2. Windfalls:

Following several heavy Mono winds which occurred during the winter of 1919-1920 an unusual number of windfalls occurred on the project area. The greater part of these occurred in the North-fork district, very few being present in the Chiquito basin. Over 304,000 board feet of sugar pine windfalls were found within four sections in the Ellis Meadow district on Unit 29.

Practically all of the yellow pine windfalls were infested during the early part of the season, and many were in a condition to

treat during the first trips over the area. The broods, however, were not as heavy as in the summer trap trees. Difficulty was also experienced in peeling bark from the windfalls. This happened to be due to some extent to the sap conditions as windfalls occurred during the winter. Trap trees felled during summer season when sap was flowing not only attracted stronger broods but peeled much easier.

Sugar pine windfalls attracted fairly good broods in the Chiquito and Dalton basins where only a limited number occurred. The heavy concentration of windfalls which occurred in the vicinity of Ellis Meadow were a failure as traps. This was apparently due to the fact that the amount of infestation in the surrounding territory was very light and not sufficient to lead the great amount of available trap material. The result was that the attacks of the beetles were scattered, occurring in patches here and there on some of the logs. Of 304,540 board feet in the vicinity of Ellis Meadow only 51,810 or 17% was attacked sufficiently to warrant treatment, up until August 30.

On the whole, windfalls are a complication in the plan of maintenance control. They are difficult to locate, often occur at inaccessible points, and usually are felled in the winter season when sap conditions of the trees are not favorable for trap material. In any ordinary season they do not occur in sufficient quantity to seriously interfere with the summer work. The 1920 windfalls were exceptionally heavy, but on the whole they were satisfactorily taken care of in the progress of the maintenance work.

3. Trap Trees:

(a) Percent of Attacks in Trap Trees

A total of 203 trees, with a volume of 302,100 board feet, were felled during the progress of the season's work. Of this amount 298,530 feet were attacked - only three yellow pine trap trees with a total volume of 4,270 feet being found that did not successfully draw attacks of the beetles.

Adding to this the 393,740 board feet of windfalls that were attacked, it is evident that on the entire area during the summer flight period, the beetles were attracted to 692,270 board feet of trap material. As 247,470 feet of standing trees were also attacked, it is evident that about 73% of the seasonal infestation was drawn to traps. As indicated above, however, allowance must be made for the late attacks in green trees not detected up to January 1, 1921, and windfalls attacked after close of the summer work, which may modify this proportion to a limited extent.

(b) Character of Trap Trees:

Aside from windfalls, the trap trees which were felled can be grouped as follows:

Class 1. Healthy but otherwise defective trees. The aim was to fell trees of poor merchantable quality, or whose removal would be of benefit to the forest. These included mostly the following :

(a) Heavy fire-scars at butts.

(b) Leaning heavily so as to be in danger of falling during the winter.

(c) Crooked or deformed.

(d) Suppressed - i.e., topped by more dominant and vigorous trees and failing to make satisfactory growth.

(e) Trees with heavy mistletoe brooms.

As a rule, the trap trees felled this season were affected with two or more of these characteristics.

Class 2. Green butts of top-killed trees or trees felled because of fading or suspicious foliage and found not to be infested.

Class 3. Trees felled in road, trail and bridge construction.

The following shows the volume of trap material in each class:

| | No. trees | Volume | % Volume |
|---|---|---|---|
| Class 1 | 163 | 240,660 | 79% |
| " 2 | 20 | 44,210 | 15% |
| " 3 | 20 | 17,230 | 6% |
| | 203 | 302,100 | 100% |

(c) Treatment of Traps:

The infestation in 207,020 board feet of trap tree material was treated before the close of the season, leaving 95,080 board feet untreated. Approximately 66,000 feet, or nearly 70% of this untreated material occurred in the Chiquito basin and includes traps left by the Chiquito crew in September, which were abandoned by the time the Northfork crew reached the area in October. In all other units over 85% of the traps were treated before the close of the season and the untreated traps in nearly all cases represent broods not far enough advanced for treatment in the fall of 1920; many of these will be treated in the spring work of 1921.

The detail of the trap tree infestation is shown in Table #4.

TABLE #4

Classes of treated and untreated trap trees - season of 1920.

| Unit | Species | Class I Leaning, suppressed, etc. No. trees | Class I vol. | Class II Butts of top-killed trees, fading trees, etc. No. trees | Class II vol. | Class III Trees felled in road, trail and bridge construction. No. trees | Class III vol. | Total All Classes No. trees | Total All Classes vol. |
|---|---|---|---|---|---|---|---|---|---|
| **Treated Trap Trees** | | | | | | | | | |
| 24 | Yellow P. | 19 | 22,750 | | | | | 19 | 22,750 |
| | Sugar P. | | | | | | | | |
| 24a | Yellow P. | 27 | 38,780 | 5 | 13,600 | 3 | 5,900 | 35 | 56,280 |
| | Sugar P. | | | | | | | | |
| 26 | Yellow P. | 39 | 64,620 | 6 | 7,400 | | | 45 | 72,020 |
| | Sugar P. | | | 3 | 12,100 | | | 3 | 12,100 |
| 28 | Yellow P. | 13 | 7,630 | | | 17 | 13,330 | 30 | 20,960 |
| | Sugar P. | | | | | | | | |
| 29 | Yellow P. | 2 | 3,520 | | | | | 2 | 3,520 |
| | Sugar P. | | | 2 | 4,000 | | | 2 | 4,000 |
| 30 | Yellow P. | 17 | 20,410 | 3 | 3,980 | | | 20 | 24,390 |
| | Sugar P. | | | | | | | | |
| Total treated | | 117 | 157,710 | 19 | 41,080 | 20 | 17,230 | 156 | 216,020 |
| **Untreated Trap Trees** | | | | | | | | | |
| 24 | Yellow P. | 1 | 1,060 | | | | | 1 | 1,060 |
| | Sugar P. | | | | | | | | |
| 24a | Yellow P. | 8 | 7,080 | | | | | 8 | 7,080 |
| | Sugar P. | | | | | | | | |
| 26 | Yellow P. | 30 | 66,380 | | | | | 30 | 66,380 |
| | Sugar P. | | | | | | | | |
| 28 | Yellow P. | 5 | 5,670 | | | | | 5 | 5,670 |
| | Sugar P. | | | | | | | | |
| 29 | Yellow P. | 2 | 2,760 | | | | | 2 | 2,760 |
| | Sugar P. | | | 1 | 3,130 | | | 1 | 3,130 |
| 30 | Yellow P. | | | | | | | | |
| | Sugar P. | | | | | | | | |
| Total untreated | | 46 | 82,950 | 1 | 3,130 | | | 47 | 86,080 |
| Total of all - | | 163 | 240,660 | 20 | 44,210 | 20 | 17,230 | 203 | 302,100 |

TABLE #5

Average volumes and diameters of yellow pine trap trees.

Felled on San Joaquin project, season of 1920.

| Unit | No. trees | Total D.B.H. | Average DBH | Total board volume | Average board volume. |
|---|---|---|---|---|---|
| 24 | 20 | 530 | 26.5 | 23,810 | 1,190 |
| 24a | 35 | 1,002 | 28.4 | 45,760 | 1,374 |
| 26 | 69 | 2,042 | 29.6 | 131,000 | 1,898 |
| 28 | 18 | 410 | 22.9 | 13,300 | 738 |
| 29 | 4 | 124 | 31 | 6,280 | 1,570 |
| 30 | 17 | 470 | 27.8 | 20,410 | 1,200 |
| Total | 163 | 4,578 | 166.2 | 240,560 | 1,475 |
| | | | Average DBH 27.7 | | Average volume 1,329 |

(d) Rules applying to Trap Trees:

Experience during the past two seasons has emphasized the following points pertaining to the character, location, felling and treatment of trap trees:

1. Trees with very thin bark do not make desirable trap trees in summer work.

2. The most suitable diameter for trap trees is between 20 and 30 inches. Trees above 30 inches d.b.h. are not so desirable as smaller trees for traps for at least two reasons.

(a) They are harder to fall and because of greater weight it is difficult to bed them above the ground so that the under side of the log can be peeled.

(b) The amount of bark surface is much less in proportion to the volume of merchantable timber. This has been shown quite conclusively by a set of bark surface tables prepared by Mr. F. P. Keen. For example, a 40-inch yellow pine tree 100 feet high, contains three times as much merchantable volume, as a 26-inch tree of the same height, but it is covered by only 1.5 times as much bark surface. It is evident that by trapping the infestation in smaller trees, the volume of actual loss can be kept considerably lower, even though the number of beetles is not diminished.

Trees below 20 inches do not make satisfactory traps as they dry too quickly and the bark is usually too thin for suitable trap material.

The average volume and diameter of selected trap trees felled during 1920 season is shown in Table #5.

3. Traps should be located for the summer work near openings so that solar heat exposure may be found for the infested bark. If the top of the trunk is exposed to the sun, it should be covered with limbs and brush after felling so as to shade this during the period of attacks. As a rule, the beetles will avoid attacking any portion of a prostrate trunk which lies exposed to the mid-day sun.

4. Trap trees should be felled so that the trunk lies as nearly as possible in a north and south line. Bark falling on either side of the trunk during peeling will be exposed during at least part of the mid-day period.

5. Trap trees should be felled at visible points along roads and trails whenever possible. This makes it much easier for the crew following for subsequent treatment to find them.

4. EFFICIENCY OF SOLAR HEAT METHOD OF CONTROL.

Burning of infested bark was continued as late as possible during the spring period. On the whole, this is considered the least expensive and most effective means of destroying the broods. It was still possible to do some burning in June, but the fire risk is so great that all control on this project should use the solar heat method during June, July, and August.

Studies of the degree of heat reached by the exposed bark and the effect of this heat upon the broods were made at intervals during the summer. Results from two of these tests are shwon in Charts #3 and #4.

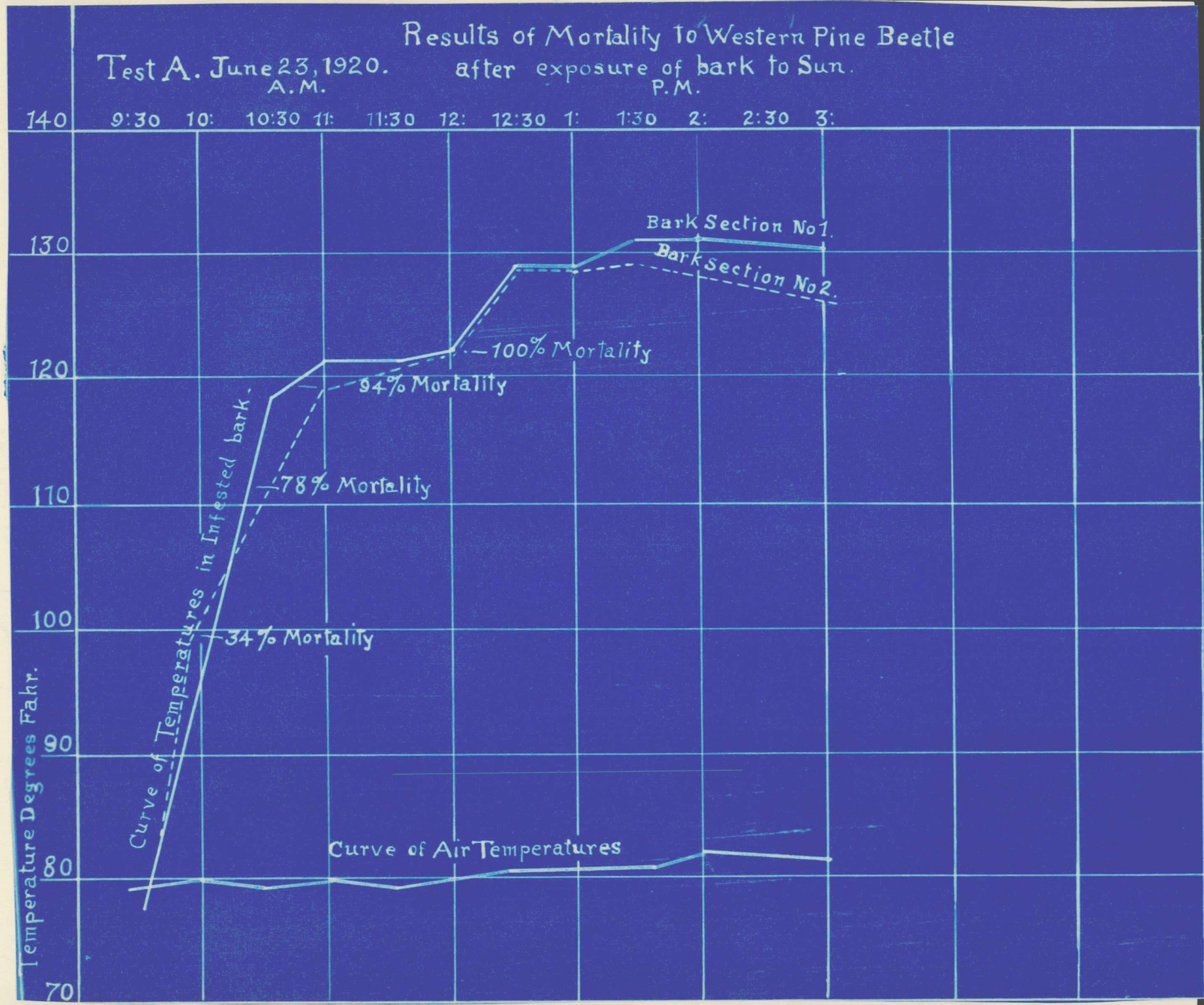
The following maximums were reached on dates in June, July, and August:

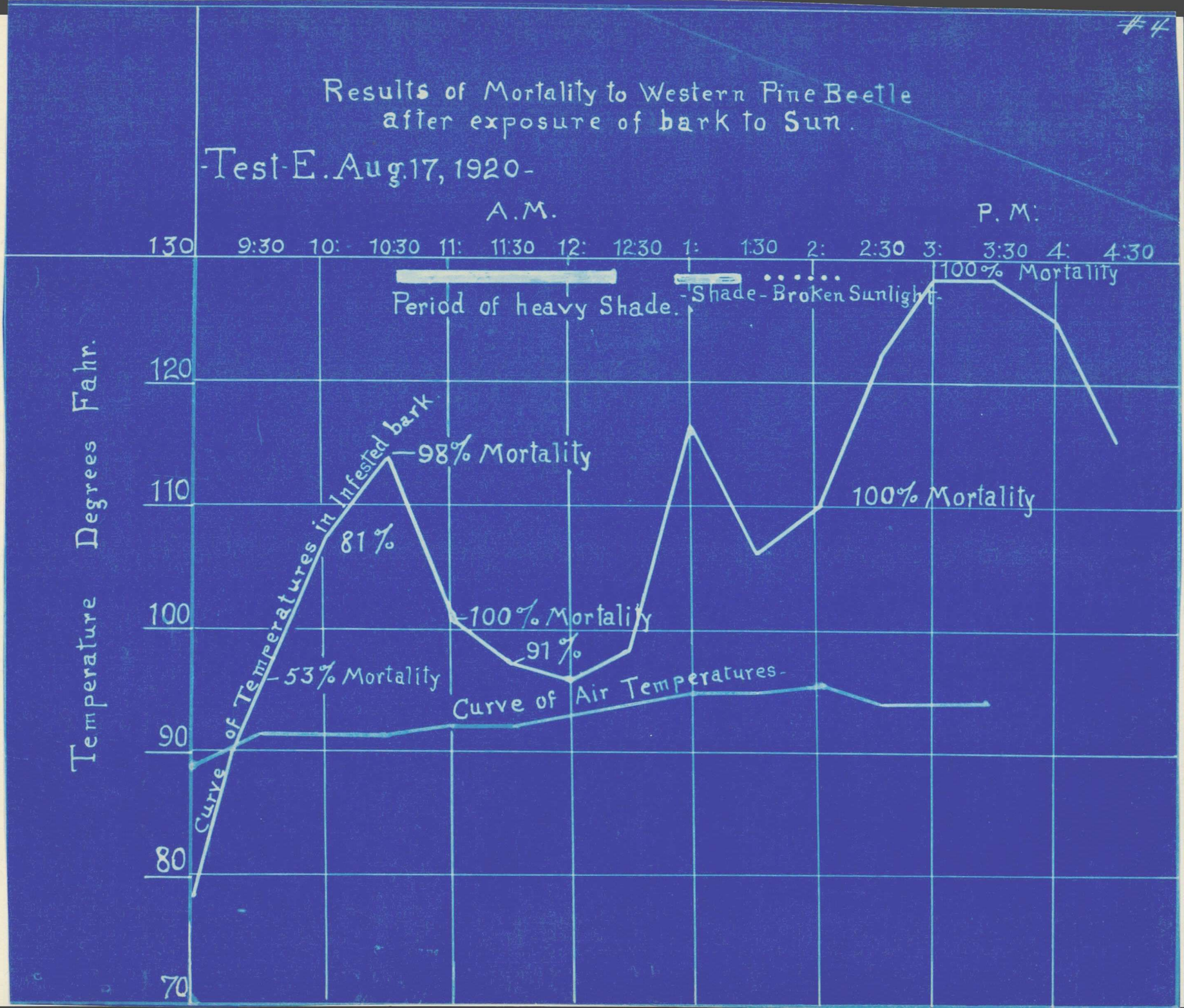
| Date | Maximum air temperature | Maximum bark temperature. |
|---|---|---|
| June 23 | 84° | 132° |
| July 17 | 96° | 128° |
| August 17 | 96° | 128° |

It was found that the amount of heat absorbed by the bark varied from day to day, according to atmospheric conditions. The degree of heat also varied in different sections of bark, and bark which had become very dry absorbed heat faster than that which was more moist.

The angle of exposure to the sun's rays also has a very marked effect upon the degree of heat absorbed by bark sections. A south slope is therefore the most desirable location for bark exposure. During the summer months, however, any exposure except a northern one will result in bark temperatures sufficient to kill the broods. After September first, however, as the angle of the sun's rays become lower it is difficult to secure effective bark temperatures unless the sections are tipped directly to the south.

In all tests made, no broods were found which survived, even for a short period, in a bark temperature of 120° or more. Mortality, however, occurs between 110° and 120° and increases according to the


Results of Mortality to Western Pine Beetle
Test A. June 23, 1920. after exposure of bark to Sun.
A.M.
P.M.
9:30
10:
10:30
11:
11:30
12:
12:30
1:
1:30
2:
2:30
3:
140
130
120
110
100
90
80
70
Temperature Degrees Fahr.
Bark Section No 1.
Bark Section No 2.
100% Mortality
94% Mortality
78% Mortality
34% Mortality
Curve of Temperatures in Infested bark.
Curve of Air Temperatures


Results of Mortality to Western Pine Beetle
after exposure of bark to Sun.
-Test-E. Aug. 17, 1920-
A.M.
P.M.
130
9:30
10:
10:30
11:
11:30
12:
12:30
1:
1:30
2:
2:30
3:
3:30
4:
4:30
Period of heavy Shade.
-Shade-
Broken Sunlight-
100% Mortality
Temperature Degrees Fahr.
120
110
100
90
80
70
Curve of Temperatures in Infested bark
98% Mortality
81%
100% Mortality
100% Mortality
91%
53% Mortality
Curve of Air Temperatures-

length of exposure. It was found that exposures of one or two hours during the middle of the day was for all practical purposes, sufficient to kill the broods in the bark.

A much more detailed and highly analytical study of this method of control was made by Mr. J. E. Patterson at Ashland, Oregon. His experiments were carried out in the field at a point about 400 miles north of the San Joaquin area and at an elevation of 4,000 feet. The maximum air temperatures were several degrees lower than those obtained at Northfork, and the higher latitude and elevations of the Ashland experiments put this method to a more severe test than occurred under conditions at Northfork. Mr. Patterson's conclusions are stated by him as follows:

"That the efficacy of this method of control of Dendroctonus breviconis is well established. That in this latitude the method is productive of results fully equaling those of the established method of burning the infested bark.

The method is practicable and efficacious throughtout the summer period when the maximum air temperatures range between 80 and 100 degrees.

The method is also applicable during the fire season, when burning infested bark would be extremely hazardous, and in forested areas where fire danger is excessive.

A certain range of maximum bark temperatures is a requisite to produce a sufficiently high brood mortality to make the method successful in application. These temperatures normally prevail during the summer period throughout the pine forests of this region. Bark temperatures above 115 degrees are productive of satisfactory results.

The tests indicate that:-

Bark temperatures below 90° are not sufficient to appreciably affect the mortality of the broods:

Critical bark temperatures range between 100° and 115°. Forty to ninety percent of the broods are killed within this range of temperatures:

Bark temperatures above 120° are approximately 100 percent fatal. Prolonged exposures at bark temperatures of 115° are 100% fatal. Absolute mortality is assured with one hour's exposure at 130° bark temperature.

Safe temperatures prevail before 10:00 A.M. and after 4:00 P.M. During these periods the maximum bark temperatures do not exceed 100 degrees.

Critical temperatures prevail during the periods from 10.00 A.M. to 11:00 A.M. and from 3:00 P.M. to 4:00 P.M.

The minimum duration of exposure, 95 percent or more fatal to the broods, is 30 minutes.

During the early larval stage, (before the small larvae have entered the central layers of the outer bark) one day's exposure of the bark under normal forest conditions, and even in shaded positions, is 100% fatal to the broods.

The percentage of relative humidity persent in the air during the period of the tests did not appear to be a factor noticeable influencing the mortality. It would appear that a high relative humidity would lower the mortality at a given bark temperature. However, this was not determined, though the tests indicated that the bark temperatures and the duration of the exposure were the two factors controlling the morality."

During the progress of the work at Northfork, a check was made on actual results of the control work under this method by later examination for exit holes in the exposed bark of most of the treated trees. It was found that all bark properly exposed during June, July, and August showed satisfactory results. Bark exposed after September 1 frequently failed to show good results unless the sections were tipped toward the south and exposed without shade the greater part of the day.

Burning of infested bark was resumed about the last of September and early rains made it possible to continue this method during the remainder of the working season.

## V PLANS FOR SEASON OF 1921 AND SUBSEQUENT SEASONS.

The results of the 1920 season brought out certain disadvantages, as well as advantages, of the scheme of administration proposed for the project in the working plan of June 1, 1920.

It is now believed that a summer trap tree work can be handled to the best advantage during the months of June, July, and August, and two trips through the area will give the maximum of results for the time expended.

It is planned, however, to work the accessible parts of the Northfork district more intensively by making a third or possibly a fourth seasonal trip through the area to determine what advantages, if any, can be gained, by working over the area with greater frequency.

It is possible that when the infestation has been reduced to a very low point it can be held by working the territory at less frequent intervals, and that on some parts of the area, summer work on alternate years will be sufficient to maintain control.

Definite plans for each season will be formulated upon the basis of a survey, to be made as early as possible in the spring, of conditions throughout the project. For the season of 1921, summer maintenance work will be started May 16, and close about August 15.

In the Chiquito district, which must be covered entirely by trail transportation, a four-man unit crew will be given a careful test for efficiency. This will be organized as follows:

1. Cruiser, in charge.
2. Fallers.
3. Packer and cook.

Transportation will be handled by two pack animals, with

an additional saddle horse for the packer.

In 1920, this part of the area was covered by a two-man crew, who did their own packing. This crew failed to cover the territory adequately. It is believed that the four-man crew will make a much more efficient working organization and that the additional expense entailed will be warranted in giving it a thorough test.

The patented lands, formerly belonging to the White and Friant Lumber Company, will be included in the summer maintenance work of the Northfork district. This will add to the amount of the area covered in 1920, and in order to provide for this, a three-man crew has been decided upon for this district. Transportation will be mainly by truck, which will eliminate care of stock and packing, so that a cook will not be provided for the crew which will consist of one cruiser in charge and two fallers.

Plans for seasons subsequent to 1921 will follow the general scheme outlined, but are necessarily subject to modifications according to local developments. The initiation of a large logging operation on the area within the next two years will require a revision of plans so that the plan of control will conform to the artificial disturbance of conditions created by a considerable amount of slash in one locality.

## VI RESULTS ESTABLISHED AND FACTORS STILL TO BE DETERMINED.

The points which now appear to be settled by the progress of this project to date are the following:

1. That the trap tree can be successfully utilized in localizing infestation at accessible points and in holding the infestation in trees of inferior merchantable quality.

2. That the solar heat method of destroying western pine beetle broods can be relied upon to supplant burning of the infested bark during the months of June, July, and August.

3. That the application of these two methods during the summer season over an extensive area will contribute to a material reduction in the volume of infested timber.

Factors yet undetermined, which will be made the subject of further study in the administration of this project are the following:

1. Organization of summer maintenance work with reference to the most economical and efficient unit crew.

2. Extent of area and volume of stand which can be effectively handled by the unit crew.

3. Extent of the attractive influence of trap trees and their location and spacing with reference to existing infestation.

with two types of transportation; one depending upon trails, the other on roads. Where roads are available, light trucks can be used, and it is already evident that the truck increases greatly the working radius of the crew both for insect control and fire emergencies. A satisfact-

ory solution of the transportation problem is necessary before the ultimate limits of the maintenance system of control can be arrived at.

## VII FACTORS DETERMINING VALUE OF MAINTENANCE CONTROL WORK ON THE SAN JOAQUIN PROJECT.

It is considered that the results of the San Joaquin project will determine whether the scheme of maintenance control can be successfully applied to these conditions at a cost in keeping with the results attained. The factors upon which these points are to be decided should be thoroughly understood and outlined in advance.

Results of the first season's work show that the cost per M.B.M. of timber treated is less for the summer maintenance work than for work carried out on overwintering infestation in the winter and spring period. It is not believed, however, that this should be accepted as the basis for rating efficiency of control work. The greater the volume of infestation on an area, the easier it becomes to find and treat infested trees, so that all other conditions being equal, the cost of control per board foot measure decreases as the volume of infestation increases.

As the infestation decreases, however, the cost per board foot volume increases because of the greater spacing and inaccessibility of infested trees.

Obviously the purpose of control work should be to prevent and decrease infestation, not to increase it. An efficiency rating on a cost per board foot basis would indicate that efficiency can be increased only as the infestation and actual loss of timber increases.

A much more logical way of rating efficiency will be to assume the amount of protection secured as a basis factor. In other words, the efficiency of the project should be gauged by the amount of timber saved, not the amount of timber treated.

This is a difficult factor to arrive at, as there is no way of determining just what the course of the infestation might be if no control were being done on the area. One system of arriving at this would be to select a check area where no control work is being done and compare the course of the infestation on the check with that of the control area. Experience with check area, however, has shown them to be very reliable factors. Check areas may be influenced by natural factors quite different from those existing on the control area. A fair comparison can only be obtained when the conditions on the check area are identical with those on the control. It would probably be impossible to find two large areas identical in all respects in the yellow pine belt.

A more satisfactory basis for efficiency rating would be to compare the amount of annual loss resulting under the maintenance system with that occurring under the method of protection previously applied to the area.

In 1917 a total of 4,803,000 board feet yellow pine and sugar pine were killed. This is an estimate based upon a survey of the entire area and control work of that season. This represents a season of epidemic conditions. Approximately 50% of this volume was treated.

In 1919 a total of 2,349,500 board feet were killed, this figure being determined by trees actually marked and recorded. This was lower than 1917 by 50%, and it is considered lower than the average annual loss that has occurred at any time during the past seven years.

We may assume that a loss of 2,350,000 board feet is as low an annual loss as can be expected under the system of working only overwintering infestation, or under an endemic condition due to natural control. It represents a loss of 1/10 of one percent of the total pine stand.

Under the summer maintenance control the loss on the area was held to a board foot volume of 247,470 standing trees and 302,100 trap trees. This represents a loss of 549,570 board feet exclusive of windfalls which cannot be considered in any way a loss attributable to insects although they undoubtedly helped to hold a considerable part of the infestation.

It is estimated that by the time all green overwintering trees have been marked, the 1920 seasonal loss will amount ot 700,000 board feet.

Assuming this to be the case, the annual loss for 1920 will be less than that of 1919 by more than 1,600,000 board feet.

This represents a saving of stumpage value of $5,000.00 The cost of the summer maintenance work responsible for this saving amounted to a little less than $2500.00 It may be said, therefore, that timber was saved at a cost of $1.56 per M.B.M.

The cost of the maintenance system of control will be practically a fixed sum annually, as in maintaining a fire patrol system. It is evident that if the amount of timber treated annually is still further reduced the cost per M.B.M. of its treatment will increase. But as the amount of timber saved will be increased, the cost per M.B.M. of timber saved will be decreased. This seems to be the most logical of efficiency rating on this project.

If a saving of 1,600,000 board feet of timber, as indicated, can be affected annually by applying this system, a stumpage value of $3.00 per M will enhance the forest resources of the area by $4800.00. It is considered that the method can be applied to the entire area at a cost of $4000.00 annually, leaving a net gain in value of $800 for the season's operation. However, the average annual loss on the area for the past seven years has approximated 4,800,000 board feet, or $14,400.00. If we assume this average annual loss as the factor for computation in comparison with 700,000 loss under the maintenance system, a saving of $10,000 becomes evident.

For all practical purposes, it seems reasonable to assume that from an insect control standpoint alone, an annual expenditure of $4,000 annually on this project is warranted, so long as the loss is held down to a volume of one million feet or less.

In addition to the insect control feature, there are other intangible assets which still further warrant continuation of the project on the basis this annual expenditure. Among these may be mentioned:

1. Investigative value of work.

2. Insurance against epidemic conditions with increased losses.

3. Increased fire protection on the area, due to patrol and fire suppression by control crews, and elimination of dead snags.

4. Holding of annual loss to trees of low merchantable value through trap tree selection.